

THE AUDIO LEAGUE REPORT

Pleasantville, N. Y.
Vol. 1, No. 8

Price \$.35
12 issues \$3.00

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THE AUDIO LEAGUE

TONE ARMS

The arm bears the same relationship to the cartridge as the enclosure does to the speaker. This fact is not as widely appreciated as it should be, perhaps because the audible contribution of the arm is somewhat less obvious than that of the speaker enclosure.

As is the case with the speaker enclosure, the tone arm generally affects only the lower frequencies. The reproduction of the middle and high frequencies is determined by the cartridge (or the speaker) alone. The coupling of the speaker to the air at low frequencies is the function of the enclosure --- and the coupling of the record groove modulation to the stylus at low frequencies is largely a function of the arm.

The arm has still another task which has no equivalent in a speaker system. For undistorted reproduction, it is necessary for the stylus motion to be along a radius of the record disc. In the recording process, a lathe mechanism feeds the cutter in along a radius of the master disc, so this requirement is met. Unfortunately most arms do not allow the pickup to move on a radius of the record, so there is an error angle between the cartridge axis and the record groove. The arm would have to be infinitely long to reduce this error to zero. For practical arms, the error is minimized by off-setting the cartridge so its axis forms an angle with the line connecting the stylus to the vertical pivot of the arm. There is also a slight amount of overhang with the stylus extending beyond the center pin of the turntable. The combination of these two factors gives a very small tracking error anywhere on a 12" disc. The better arms (such as Pickering or Fairchild) have reduced tracking error to less than 2°-3°. The distortion resulting from such an error is low enough to be neglected in a practical reproducing system.

Each manufacturer gives complete mounting data for his arm. This should be followed carefully, since an error of as little as 0.1" in overhang may cause a tracking error of 2°, thereby negating the manufacturer's design efforts. Even if the arm is properly mounted, changing to a different make of cartridge may introduce an appreciable error, since the distance from stylus to mounting holes may vary from one make of cartridge to another. For this reason, it is generally preferable to use the arm manufactured by the cartridge manufacturer or recommended by him.

The major resonance in an arm-cartridge combination is due to the lateral compliance of the stylus and the total mass of arm and cartridge referred to the stylus tip. This occurs at frequencies of 30-40 cycles when using a typical magnetic cartridge in a record changer arm, and at 20 cycles or below when using a properly designed separate arm. With a massive arm and/or a highly compliant cartridge, the resonance may even fall below 10 cycles.

It is important that the resonance be kept away from the 30 cycle region, since this is the predominant rumble frequency for turntables equipped with 4-pole induction motors. Inasmuch as frequencies below resonance will be greatly attenuated it can be seen that in any system which aims at rumble-free reproduction of notes below 40 cycles, a good quality arm and cartridge resonating at or below 20 cycles is a necessity.

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Not all separate arms give equal performance in this respect. Some have greater mass than others and thus a lower resonant frequency. While increasing arm mass will reduce the resonance of any arm, there is a limit to which this can be carried as bearing requirements become more severe. Worse yet, any record hole eccentricity (always present to some degree) will have a greater effect on increased record and stylus wear when lateral arm mass is excessive. The possibility of distortion as the stylus is driven to its limits twice per record revolution, especially with highly compliant cartridges, becomes more important.

Increasing lateral stylus compliance also lowers the resonant frequency, without accentuating bearing and wear problems. There is still the danger of over-driving the stylus on eccentric records. Actually, a compromise must be reached between the two approaches to the problem. In view of the additional advantages of high lateral stylus compliance in regard to improved high frequency tracking and reduced record wear, it is not surprising to find the current trend favoring highly compliant cartridges rather than unduly heavy arms.

There are several distinct design philosophies evident in the arms on today's market:

One type has its horizontal and vertical pivots quite close to each other. (The horizontal pivot allows vertical movement of the cartridge and the vertical pivot permits the arm to follow the record grooves toward the spindle.) These arms are not balanced about the vertical axis and so must be carefully leveled if satisfactory tracking is to be had. When mass counterbalancing is employed (as in Livingston, Clarkstan, ESL 310, Audak, B-J and Gray 108B arms), the vertical mass is generally quite high. When playing a badly warped record with such an arm, the variation in instantaneous stylus pressure may be considerable during each record rotation, and sometimes the stylus will leave the groove completely after rising to the crest of a warp. There is also a possibility that record wear is accentuated by the existence of any large mass which must be accelerated vertically. On spring counterbalanced arms, such as all record changer arms and the Ronette FF-2, this problem is not nearly so severe.

A second type is balanced about the vertical axis. Leveling is of secondary importance with such an arm if the balance is precise. Arms in this category include Fairchild, Pickering, and Weathers. In order for such an arm to have any net downward stylus force, its horizontal pivot must be located apart from the vertical pivot. Exception: the case of the Weathers arm which employs a toggle action

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spring to provide a downward force. This unusual arm is so independent of any need for leveling that it could play upside down if the record would not fall off the turntable. We have used the Weathers arm with the turntable tilted up at almost 90° with no detectable degradation of performance. The vertical mass is still relatively high with this arm, but in view of the extremely low tracking pressures employed, no record wear problem is likely to be encountered.

The Fairchild and Pickering arms make a distinct effort to reduce vertical mass. The Fairchild horizontal pivot is not far forward of the vertical pivot, but the front end of the arm is a light aluminum extrusion and a spring counterbalance is used to adjust stylus pressure. Pickering carried reduction of vertical mass to its ultimate conclusion. The horizontal pivot is just behind the cartridge, so that the only vertical mass is the cartridge itself, and the small aluminum bracket on which it mounts (spring counterbalancing is employed, of course).

We believe that, in their attempt to minimize vertical mass, Pickering has overlooked an important factor. Most records are warped to some degree. If the distance from stylus to horizontal pivot is too small, the angle between the stylus and the record surface will change in accordance with the warp of the record. This in effect will frequency modulate the recorded signal resulting in a "wow". A longer horizontal pivot-to-stylus distance will produce less "wow" on a warped disc than will an excessively short distance. Eventually the "wow" will become so small as to be undetectable.

On certain warped records (approximately 3/16" warp) we have noticed a most unpleasant "wow" when using a Pickering arm which completely disappeared when a Fairchild arm was used. Admittedly, this amount of warp is excessive, but for those who may have records in this condition, this is a factor to be considered.

There is considerable variation among arms in the type of bearings employed. We are of the opinion that most arms we have examined have satisfactory bearings, and that, in practise, there is little difference between needle bearings, ball bearings, or sleeve bearings.

Most arms employ ball bearings on the vertical pivot. These vary considerably in quality, from the cheap but adequate bearing in the little Ronette FF-2 arm, to the precise instrument bearings of the ESL-310. The latter has the freest running ball bearings we have seen on an arm - the base will continue to revolve for 10 or 15 seconds after being spun by hand.

The Fairchild arms use pivot-type bearings on both vertical and horizontal axes. These consist of small cylindrical pivots turning in a cup drilled into the end of a screw. These are simple devices, which never need lubrication and which should retain their original performance characteristics indefinitely. Fairchild advertising implies that a controlled amount of friction is designed into these pivots, in order to improve tracking. More about this later.

The Pickering 190D has the lowest friction vertical pivot of any arm we've seen. In fact, it has no close competition in this respect - really is in a class by itself. A sleeve bearing, machined with great precision, does the job, with a ball to take the vertical thrust. Spinning the base of the Pickering 190D gives one the impression that it is suspended on air. It spins for a full minute when once started.

Most of the arms we examined had some form of needle or pivot bearing for the horizontal pivot. The requirements for this pivot are not so severe as those for the vertical pivot.

It is frequently assumed that it is desirable to reduce friction in the vertical pivot to a minimum for best tracking and lowest record wear. Actually this is an overamplification of the case, which would apply only if there were no friction between the stylus and the record surface.

Unfortunately, there is friction at this point. With an arm properly mounted and offset for minimum tracking error, the stylus/record friction has a component of force tending to carry the arm in toward the center of the record. The record groove, instead of leading the stylus inward as is commonly supposed, actually resists the natural tendency of the arm to ride in to the center of the record.

If a small amount of friction exists in the vertical pivot bearing, it will reduce the tendency of the pickup to move inward, and less force will be exerted by the record groove to keep the pickup in the proper path. This means reduced record and stylus wear, plus less tendency to jump out of the groove when jarred.

The problem, of course, is to build in the correct amount of friction and keep it from changing. This is probably impossible with any commercial bearing. Nevertheless, as long as the friction does not exceed twice the optimum amount, it will do some good and can do no harm. This, we believe, is the intention of the Fairchild pivots. The presence of the friction is definitely noticeable (not to the touch - it is much too small for that), particularly when compared to the Pickering 190D, which is nearly frictionless. When the arms are mounted and carefully leveled, and then given a slight push, their behavior is quite different. The Fairchild drifts along, slows down, and stops quite definitely. The Pickering slows down, stops, floats back and forth a little, and generally gives the impression of being ready to take off again on its own.

Another feature of some arms which arouses violent controversy among audiophiles is viscous damping. The major reason for using viscous damping is to reduce or eliminate the low frequency resonance of arm mass and stylus compliance. In the Fairchild 202 arm, this damping is applied only around the vertical pivot; in the Gray 108B and 108C, it is applied to both pivots. The Gray arms have a unique "feel". The degree of damping is adjustable and when an appreciable amount is used, the arm will float down slowly to the record if it is released from a height.

Some of the arguments on the subject of viscous damping are:

PRO: The resonances are definitely minimized. Dropping the arm cannot harm the stylus or the record.

CON: When playing a warped record, the stylus may leave the groove completely in the trough of a warp, or gauge the record on the crest of a warp.

Counter-arguments are:

PRO: Very few records are badly warped.

CON: Proper design of a conventional arm and cartridge can reduce low frequency resonances to the point of insignificance.

The Audio League will not take a stand on these issues, in the complete absence of experimental evidence. The arm manufacturers each claim their particular product is superior, and no one seems to have any reliable test data to prove it. Our tests have not shown any substantial differences in performance between the better makes of

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arms. If there are any, they show up at a level calling for a greater degree of refinement than the ones we employed, and certainly would not be audible.

We believe that the only important differences between arms and possibly between some of the better cartridges lie in the field of record and stylus wear. We have some thoughts on a series of exhaustive tests to clearly point out any such differences if they truly exist. These tests will consume considerable time and money. If the Audio League grows to an extent which permits such an expenditure, we will undertake the study. In any event, don't expect any results for some months, at least.

INTERPRETING LOW FREQUENCY RESONANCE CURVES

The curves shown in this section indicate the effect of two quantities: total lateral mass of arm and cartridge, and stylus lateral compliance, (and, to some degree, low frequency damping of the cartridge). Therefore it is perhaps misleading to include this data in ratings of arms. Nevertheless we feel that it can serve to give the reader some idea of what happens when he tries to play (for example) one of Emory Cook's organ recordings with those 16 cycle fundamentals.

In general, it can be said that the arm resonance we've just described should occur as low as possible. Actually, if it were too low, say about 1 cycle or less, any eccentricity in the record would be splendidly reproduced, doubtless overloading the entire playback system. Since frequencies below resonance will not be reproduced, or at any rate will be severely attenuated, the resonance should be below the lowest frequency one might expect to reproduce. For most practical purposes this would mean below 32 cycles, but the aforementioned organ records and other specialty records contain frequencies as low as 16 cycles. If one's speaker can do even a half-hearted job down there, it would be well to give it a chance. (Not many can hold their own even at 32 cycles, but that is another story).

The 30 cycle region must be avoided in choosing the lowest pickup resonance. This is the fundamental rumble frequency of most turntables, and if the resonant peak falls at this frequency there will be trouble. Many record changers produce excessive rumble because of this unhappy circumstance.

Therefore it seems that one would like to keep his arm resonance well below 30 cycles, and preferably below 16 cycles. In addition, the amplitude of the resonant peak must be considered. If it is too great, there is a possibility of jumping out of the groove on high amplitude low frequency tones, or of some of the rumble components derived from the idler wheel being unduly accentuated (these may fall in the 5-15 cycle region).

In practice we have found that an arm/cartridge combination whose resonance is not higher than 22 cycles or greater in amplitude than about 10 db is satisfactory. Some which have higher peak amplitudes do quite well, while some with lower peaks may still show a tendency to leave the record groove. If the resonant frequency is below 16 cycles, the amplitude is less important since no musical content exists down there.

Incidentally, the low frequency resonance is not entirely harmful. Most preamplifiers do not fully equalize below 30 cycles. For economic and technical reasons, it is convenient to carry the low frequency equalization boost down to 30 or 40 cycles and level off, with the result that frequencies below 30 cycles are attenuated in reproduction. An arm resonance down there will tend to compensate for this loss.

MEASUREMENT OF LOW FREQUENCY ARM RESONANCE

Some readers may have wondered how we measure arm/cartridge response at frequencies below 20 cycles. We play a Folkways FFX-100 frequency test record, which has recorded frequencies of 15.6, 22.4, 31.3, 44.2, etc. cycles at 78 RPM. When this record is played at 33 RPM, the outputs are at 6.6, 9.5, 13.3, 18.9, etc. cycles per second. Intermediate frequencies are obtainable by playing the record at 45 RPM. By measuring the response at all three speeds, a fairly smooth curve can be drawn. We haven't found an arm or cartridge yet whose resonance doesn't occur above 6.6 cycles, though the ESL Concert Series/Fairchild 281 combination comes pretty close to the edge!

STYLUS PRESSURE GAGES

In recent years we have been made aware of the need for accurate adjustment of stylus pressure. Each arm/cartridge combination has a certain range of pressure over which it will give proper electrical performance with a minimum of distortion and record and stylus wear.

Too little pressure will result in severe distortion, plus increased record wear. Too much pressure will increase both record and stylus wear, though distortion will generally not suffer. When in doubt, it is better to have the pressure on the high side rather than too low (might as well get clean reproduction while destroying your records and styli). Naturally, the optimum pressure should be used if it is at all possible.

As we stated in our discussion of test records last month, in our opinion one of the neatest ways of determining the optimum stylus pressure is to play a Cook Series 50 intermodulation test record (or any other type of IM record if suitable instruments are available for measuring IM distortion.)

As pressure is reduced, one of two things will happen. Either (1) the IM distortion will begin to rise, or (2) the pickup will tend to part company with the groove and skitter around on the record at the least provocation. The lowest pressure at which neither of these things occurs is the optimum. Adding an extra gram as a safety margin is a good idea.

In the absence of such a test record, the manufacturer's recommendations should be followed.

Several makes of stylus pressure gages are on the market. Those which come to mind are Audak, Clarkstan, Garrard, Livingston and Weathers. The Clarkstan, Garrard and Livingston gages are essentially small spring scales, calibrated in grams over the normal range from 1 or 2 grams up to 30 grams or more. When using the Clarkstan and Livingston gages, the stylus is placed in a cup at the end of a spring and the pressure read directly on a scale as the spring is deflected. With the Garrard gage, a lever must be manually moved along the scale until a pointer lines up with a reference mark. Its range is more limited (5-15 grams) but OK for most magnetic cartridges.

The Audak and Weathers units are true balances, using no springs. The Audak is supplied with two weights which enable exact pressures of 2-3/4 grams, 6 grams, or 8-3/4 grams to be measured. If any other pressure is desired, you're out of luck. This is fine for Audak perhaps, though high priced (\$4.80 net). We don't particularly recommend it for other makes, unless the money means nothing to you.

All the aforementioned gages suffer from an important defect. The stylus pressure cannot be measured with the stylus actually on the record. Magnetic attraction between cartridge and turntable may drastically increase true stylus pressure.

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sure over the value indicated on the gage, and some arms may show a different pressure when lifted to the height of a stylus gage lever than when resting on a record.

The Weathers gage overcomes these problems neatly. It is essentially a small postal balance, calibrated from 1/2 gram to 50 grams. It can be easily read to 1/2 gram at any pressure less than 5 grams. Best of all, it is used with the arm in playing position. With the record actually being played, the hook at the end of the gage is placed under the edge of the arm, as near the stylus as possible. The gage is lifted until the music is interrupted and the exact, true stylus pressure is read from the dial. This particular technique is essential in setting stylus pressure with the Weathers system (See our comments elsewhere in this issue) but equally desirable with any type of arm or cartridge.

The chief objection to the Weathers gage is the fact that it is in 3 pieces, which are assembled for use and fall apart only too easily. We cured this with pieces of scotch tape, placed on the main plate in such a manner as to prevent the arm pivots from slipping out of their holes. This won't make much sense if you've never seen a Weathers gage, but will be apparent to any user of this device. Accuracy is not affected by this technique.

We have used both Livingston and Weathers gages. Their readings, under identical conditions, agreed very closely. We have no reason to doubt the accuracy of any of these devices, at least within the limits applicable to their intended use.

In view of its moderate price (\$2.00), wide range and method of application, we recommend the Weathers gage most highly. Whatever make you get, get one and use it. In the long run, it will undoubtedly pay for itself.

The appraisals of arms which appear in the Reports at this time are largely based on operating experience, plus our low frequency resonance measurements. They are discussed in alphabetical order.

B-J

For as many years as disc recordings have been with us, attempts have been made to manufacture arms which eliminate the tracking error which is the inevitable result of using an arm which does not cause the pickup to traverse the same path as the cutter head. Most of these devices have failed ignominiously in practise, usually due to friction effects.

Several months ago, the B-J arm, an unusual import from Britain, appeared on the scene. Its head is mounted on two aluminum tubes which are so pivoted at each end that the head is rotated as it moves from the outer grooves to the innermost grooves of a record. This rotation is claimed to be such that almost perfect tangency is achieved between pickup and record groove over the entire playing surface of a 12" record.

Several independent groups have gone to the trouble of laying out the dimensions of the B-J arm to scale on the drafting table and measuring the tracking error. They have reported a tracking error not exceeding 1°. We have not gone to this extent in verifying the B-J design and will accept the 1° figure unless we are given a good reason to doubt it. By way of comparison, the Pickering 190D and Fairchild 280/281 arms are claimed to have maximum tracking errors of 2° or so.

The latter arms achieve their low tracking errors by virtue of considerable pivot-to-stylus length, plus carefully calculated offset angles. The overall length of a Fairchild 281 arm is 17 inches and the Pickering 190D is 14 1/2 inches long. Contrast this to the 9" length of the B-J, which extends a maximum of 10-3/4" from the turntable center. It is apparent that the B-J arm offers (as far as tracking error is concerned) the performance of a transcription arm in a unit the size of a record changer arm.

The pivot assembly housing (as well as the head) is made of black bakelite. It is unusual in that it does not rotate about the vertical axis. The two aluminum arms are pivoted on needle bearings within this housing, which is only free to move about the horizontal axis. The only adjustment of stylus pressure is by means of a number of trapezoidal lead plates which may be screwed to the underside of the pivot assembly housing (this is our name for it, for want of a better one!). This stylus pressure adjustment is clumsy and time consuming, since the arm must be removed and laid on its side for each successive cut-and-try operation. Surely some more satisfactory method could be devised.

The head is equipped with knockout sections and will accommodate any standard cartridge including turnover types. A convenient finger lift is attached. The height of the arm is adjustable up to 2 1/2", adequate for any turntable we've encountered (ours cleared the Rek-O-Kut T-12 easily).

The bearings employ hardened steel inserts set into the aluminum tubes. They are adjustable in case any binding or play should develop. Ours felt very smooth as delivered and we never attempted to adjust it.

The unusual design of the B-J arm means that the lateral mass is substantially less than that of conventional arms, although it is not at all balanced. Leveling of the arm is important, but it should be expected to track eccentric records easily. It does. A 45 RPM disc placed on the turntable with the spindle against one side of the center hole was easily tracked by our B-J arm/Fairchild 220 cartridge combination at 8 grams stylus pressure.

Although the counterweight of the B-J arm is quite heavy, it is very close to the horizontal pivot axis. As a result, the vertical moment of inertia (which is what we have been rather loosely referring to as vertical mass) is reasonably low.

An arm rest is supplied with the arm, as is a template for locating the arm relative to the turntable. This is a valuable aid to getting proper performance from an arm, since it eliminates any ambiguities in locating the arm on the motor board.

As an indication of what order of low frequency performance may be expected from the B-J, we offer Fig. 1, which shows the response of a Fairchild 220 cartridge in this arm, using the Folkways FPX-100 test record.

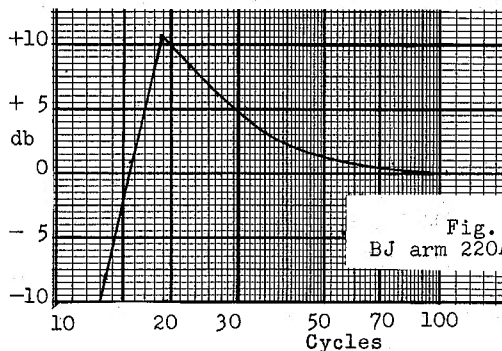


Fig. 1.
BJ arm 220A cartridge

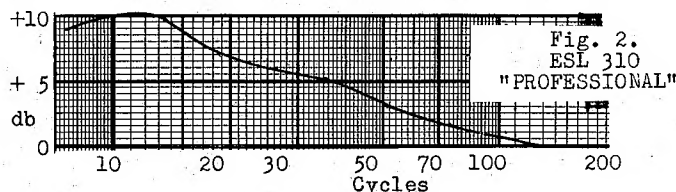
ESL PROFESSIONAL ARM, MODEL 310

Inasmuch as this arm can only be used with the ESL Professional series cartridges, we will not go into too much detail on it. It is an aluminum tube into one end of which the ESL cartridge fits. Insertion is simple - press the cartridge plug into the receptacle and a quarter turn of a knurled ring locks it securely. Cartridges can be removed or inserted in seconds, and electrical contacts are positive.

Both vertical and horizontal pivots are located at the other end of the arm in close proximity to each other. They are precision ball bearings mounted in a gimbal structure similar to that of a gyroscope. A heavy counterweight is mounted to the rear of the pivots. It is sufficiently heavy to more than counterbalance the weight of the head, and a spring is used to provide restoring force which results in the desired stylus pressure. A knob on the rear of the counterweight permits easy adjustment of stylus pressure over a wide range from 3 grams up. A calibrated scale on the counterweight shows the stylus pressure directly. We checked it against a Weathers stylus gage and found them in perfect agreement.

A solid, machined arm rest completes the ensemble. Workmanship of the entire arm is beautiful, more closely akin to precision instrument techniques than to those found in home (or even commercial) phono reproducing equipment. Its price of \$57. net is easily justified by the caliber of its construction. This arm, incidentally, is manufactured in Denmark as are the Professional series cartridges.

The low frequency performance of the Professional cartridge in this arm is shown in Fig. 2.



Our only criticism of the performance of this arm (we've heard of several other users of the PRO having the same difficulty) is actually a result of using a piece of professional apparatus in the home. Unless the motorboard is thoroughly shock-isolated from its surroundings or used on a rigid (concrete) floor, there is a tendency for the cartridge to bounce out of the groove. When someone walks heavily in the vicinity on ordinary wooden floors, such as are found in most homes, even normal walking can jar the pickup. The problem is not solved by increasing stylus pressure - even at 8 grams it is present.

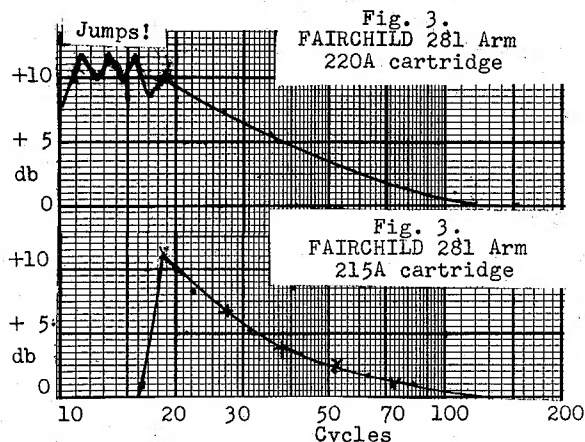
On the other hand, when suitably mounted, the cartridge and arm track very nicely at 3 grams. Leveling is also important in the successful use of this arm.

FAIRCHILD 280/281 ARMS

These arms were described in the January Report. As we have mentioned previously, the general high quality of the Fairchild arm, plus its unusual ability to accommodate almost any cartridge without the need for solder connections made it the logical choice for use in our cartridge tests.

After intensive use of our 281 (16") arm, we can think of two improvements we would like to see on future models. The first we mentioned in the January issue: the built-in detent in lieu of an arm rest, while OK when handled carefully, does not impress us as being likely to last through much use. The second is in connection with the finger lift. It is a straight piece of metal, with a small notch cut out of the bottom. Unless it is firmly gripped between thumb and forefinger, when the arm is swung over to the detent, it is all too likely to bounce out of one's hand and strike the record. A curved finger lift, similar to the ESL or Weathers type, would help to prevent this.

The low frequency resonance of the Fairchild 220A cartridge in the 281 arm is at about 13 cycles, as shown in Fig. 3. It is unfortunately not too well damped, being over 10 db in amplitude. The cartridge failed to track on the test record at resonance, jumping out of the groove. Of course,



one is highly unlikely to encounter 13 cycle components in listening to recorded music, so this is not really as objectionable as it might otherwise seem.

The old 215 cartridge resonates at 18 cps in this arm, indicating lower compliance of its moving coil and stylus assembly. However, its low frequency damping is superior as shown by the fact that the resonant peak is only about 10 db high, and it does not leave the groove.

PICKERING 190D

The latest version of the well known Pickering 190 arm is the 190D, which is several inches shorter than its predecessor by virtue of a redesigned counterweight reducing the overhang.

As our general discussion of arms indicated, the Pickering has several unique features. The most striking of these to a person handling one for the first time, is the fact that the arm does not pivot about a horizontal axis. The entire length of the 190D (some 14½") is always parallel to the turntable, and a fraction of an inch above it when properly adjusted. The finger lift, rather inconveniently located in front of the arm rather than on the side, merely moves a small fraction of an inch, enough to lift the stylus clear of the record. We know some people who find the feel of the Pickering arm so strange that they won't use it for that reason alone. We don't feel that way about it, since the design has many compensating features.

For one thing, the cartridge is fully enclosed within the arm. It cannot strike the center pin or the turntable if no record is on it. The arm is constructed of two heavy aluminum U channels, welded to form an extremely rigid rectangular cross-section. Cutouts in the bottom give access to a thumb screw which permits easy adjustment of stylus pressure. Pickering car-

tridges slide into the arm without solder connections; other makes may require a little more effort in mounting. The arm is built like a battleship and it is hard to see how anyone could mishandle it enough to damage it. The vertical pivot is the most frictionless we've ever seen. The arm literally floats and the slightest touch guides it to any position. Adjustment of vertical height is extremely simple and positive, and its mounting has the neatest leveling means of them all. The arm mounts through a single hole in the motor-board, with three adjusting screws built into the base for leveling.

The arm is balanced about the vertical axis and, as a result, leveling becomes much less critical than in unbalanced designs. It is also rather insensitive to jarring.

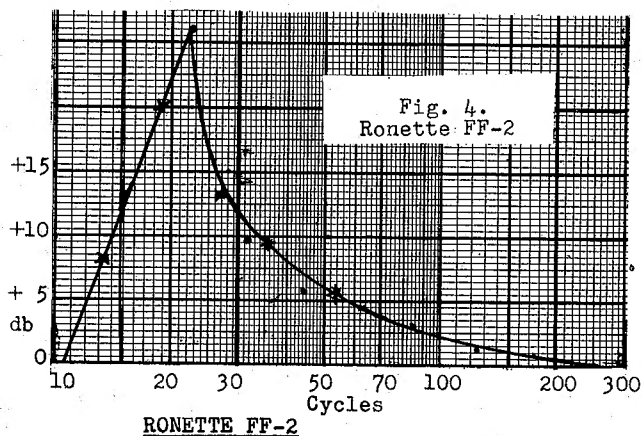
We can find a few faults in this arm, in spite of its general excellence. The horizontal pivot is only about $2\frac{1}{2}$ " back of the stylus, which means that the angle between cartridge and record may change considerably when playing warped records. The audible result of this is "wow". This is not just a theoretical consideration; we have actually observed it. The "wow" becomes virtually undetectable when played on an arm whose horizontal pivot is well back of the stylus, such as the Fairchild (or even a record-changer arm).

The cartridge is almost invisible and set at an angle (internally offset). Cueing to a desired groove is therefore a challenge to the user. Regular Pickering users seem to get along all right after a bit of practice.

As we stated earlier, the finger lift could hardly be in a more inconvenient location.

The 190D is heartily recommended for owners of Pickering cartridges. While other makes can generally be adapted to the arm, their stylii may not always fall in the right position to give the recommended overhang (beyond the turntable spindle). The Pickering cartridges are designed to fit properly, and are adjustable by means of their special "keystone clip". If another make is used, this adjustment is not available.

Unfortunately, we do not have test data on the low frequency resonance of this arm with the Pickering cartridges. We understand that it is designed to resonate at 15 cps with the 140 series cartridges, which sounds reasonable to us.



This little arm was described in our last issue. Fig. 4 shows its low frequency response with the Ronette 284P cartridge. Its low frequency damping is not too good with the peak at 22 cps being 27 db. Nevertheless, it stays with the record at all times, and 22 cps is a most respectable resonant frequency for a featherweight arm such as this. Credit, of course, must go to the remarkably compliant 284P cartridge.

ERRATA

In issue 6/7 of the Report, we let a real boner slip by. On page 11, referring to the Ronette cartridge, we said "its compliance is claimed to be quite low". What we meant, of course, was quite high" (about 3.6×10^{-6} cm/dyne).

WEATHERS DEBONNAIRE INTERIM REPORT

Our intention was to report only on the Weathers arm, cartridge and oscillator this month. However, the unit submitted to us for test was the Debonnaire, which incorporates a preamplifier, a modified General Industries Model DSS turntable, and the Weathers arm equipped (in this case) with their turnover cartridge, all mounted on an attractive formica-finished base. Under the circumstances, it was not possible to test the cartridge performance separately, since the output had to be taken through the preamplifier. Also the turntable on our test unit was defective (ran slow) so conclusive listening tests were ruled out. Nothing sounds more dismal than a record played about 3% slow!

The situation was complicated further by the unusual nature of the Weathers preamplifier. It is, (in our opinion), an example of a great deal of ingenuity gone wrong. Only one tube (a twin triode) is used in this clever device. One half is the oscillator which is a basic part of the Weathers system; the other serves as an amplifier and tone control stage. An auxiliary input for radio, etc. is provided, with the volume control serving as a channel selector. Zero volume is obtained with the control at center; counterclockwise rotation increases gain on the auxiliary input and clockwise rotation increases gain on the phono input.

Separate bass and treble tone controls are provided, continuously variable from flat to 15 db boost at 15 kc and 30 cycles. No cut is provided, since the Weathers cartridge is amplitude responsive and therefore needs little or no equalization for most records. The flexibility of the preamp, when used with a tuner, is somewhat limited, since treble cut is the most common type of equalization needed on radio programs.

The fly in the ointment is the fourth control, labeled "turnover". This varies the turnover frequency in record equalization from 200 cycles to 1000 cycles. A continuous variation like this can be handy if a number of older records or foreign records is included in one's collection, though we consider it of limited value with the relative standardization of recording characteristics existent today. The turnover control unfortunately is always in the circuit, even when using the auxiliary input. The almost complete lack of isolation between the various controls means that every control affects every other one to a greater or lesser extent. We found it to be impossible to get a flat response on the auxiliary input. By some juggling of controls, we came within ± 3 db of flat over most of the audible range.

The interaction of controls is so complete that not only do the tone and turnover controls have a considerable effect on overall volume level, but the setting of the volume control has an equally considerable effect on the frequency response! We measured the response of the preamp with numerous combination of control settings, and these are plotted in Fig. 5. The curves speak for themselves.

We're not going to tell the Weathers engineers how to design their equipment, but we do feel that the addition of another tube to isolate the controls, and keep the turnover control out of the circuit on the auxiliary input would be most worthwhile improvements.

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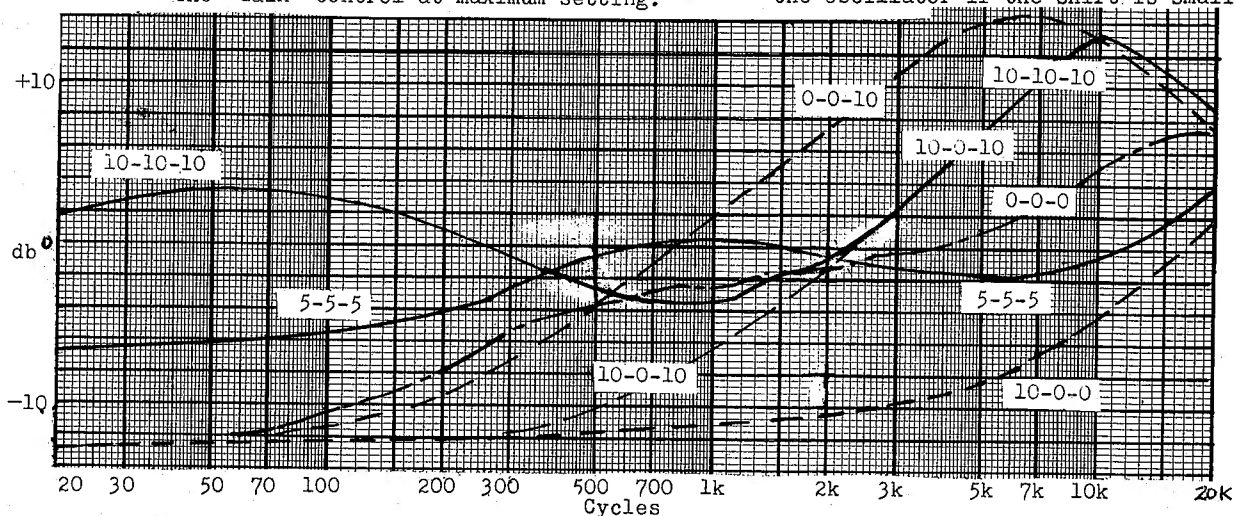
On the credit side, the Weathers preamplifier is an attractive package, with brass knobs and gold lettering on a black panel. Its hum level is extremely low (there is no need for high gain amplifiers). We measured a hum and noise level of 60 db below 1 volt output with maximum volume and the controls set for AES equalization. This is top-notch performance. Maximum output is several volts RMS at ordinary recording levels -- more than sufficient to drive any power amplifier.

The Weathers cartridge and oscillator are an ingenious method of getting sound from a record groove. The stylus moves a tiny aluminum plate which forms part of a capacitor. This motion varies the spacing between the moveable and fixed plates of the capacitor, and therefore their capacitance. A minute transformer inside the cartridge is connected to a special shielded cable which plugs into the oscillator. The oscillator operates at 21 megacycles, and the capacitance change due to stylus motion, suitably modified by the transformers, serves to vary the amount of feedback in the oscillator. This has the effect of modulating both frequency and amplitude of the oscillator. Weathers naturally plays up the frequency modulation aspect in his advertising, since FM is associated with high fidelity in many people's minds. Actually, the variation of feedback is basically used to modulate the plate current of the oscillator. This variation generates an audio voltage across a 22000 ohm load resistor, which is then amplified for further use.

WEATHERS PREAMPLIFIER

Aux. input response

Numbers refer to the settings of "Turn-over, Bass, & Treble" controls respectively. The "Gain" control at maximum setting.



As the oscillator output appears, it is about 0.8 volts at 500 cycles for 5 cm/sec stylus velocity, and is proportional to the amplitude of the recorded signal (as is a piezo-electric pickup). On Weathers oscillator units, a second jack is provided for obtaining an AES equalized output which may be used to drive a power amplifier directly without a preamplifier.

Both the separate oscillator unit and the preamplifier have high impedance outputs which means that more than a few feet of shielded wire between them and a power amplifier will cause excessive loss of high frequency response.

Weathers supplies complete instructions for adjusting the oscillator tuning. This is most important for satisfactory performance. We encountered no difficulty in adjusting ours, and it did not require any readjustment in two months of use. Earlier Weathers models were notorious for critical adjustments and drifting oscillators, but these difficulties have obviously been overcome.

Some of Weathers outstanding features are the low tracking pressure (1 gram), the extremely high lateral compliance (14×10^{-6} cm/dyne), and the low mass (1 milligram) of its stylus assembly. These properties, all highly beneficial to long record and stylus life and clean reproduction, are carried to a greater degree of refinement in this pickup than in any other we know of.

A small sable brush is an integral part of the Weathers cartridge. It rides on the record and cleans off dust particles before they get ground into the record surface. It also serves to absorb a large part of the downward force which otherwise would fall on the stylus itself. This aspect of the Weathers system has aroused some controversy in the past, since the stylus pressure as measured on any gage except the Weathers is 3 to $3\frac{1}{2}$ grams. Where, then, is the much vaunted 1 gram tracking pressure? It's there, all right. When playing a record, lifting the arm with the Weathers stylus pressure gage will kill the music at 1 to $1\frac{1}{2}$ grams, which is where the stylus leaves the record. The brush remains in contact with the record, until 3 to $3\frac{1}{2}$ grams is reached.

Naturally, the brush will take a "set" after extended use increasing stylus pressure somewhat. Periodic checks with the Weathers gage will reveal this condition. A simple adjustment of the brush is all that is needed to correct it.

As might be surmised from the minute mass and high compliance of the Weathers stylus, this is a delicate device. Any accidental dropping or other abuse of the pickup is likely to change the spacing between the fixed and moveable capacitor plates. This can be compensated for by retuning the oscillator if the shift is small, but gener-

ally will require the stylus to be physically re-adjusted. This is not difficult, and complete instructions are provided for the operation, which is also necessary whenever the stylus is replaced.

The Weathers arm is just as unconventional as the cartridge. It is made of light but rigid wood, in rectangular cross-section. The vertical pivot is of the ball-bearing type, very free in its motion. The horizontal pivot, located directly over the vertical pivot, is of the needle and cup type. Two needle points on the arm rest in cups in a cylinder which rotates about the vertical axis. A counterweight is used to balance the arm about this axis, removing the need for critical leveling. The downward tracking force is obtained entirely from a spring, which is so mounted as to give a toggle action. That is, when the arm is raised above a certain angle, it tends to rise to approximately a 30° angle to the horizontal and remains there, out of the way. When it is lowered manually below the critical angle, it snaps downward, with the spring providing a 3-gram force

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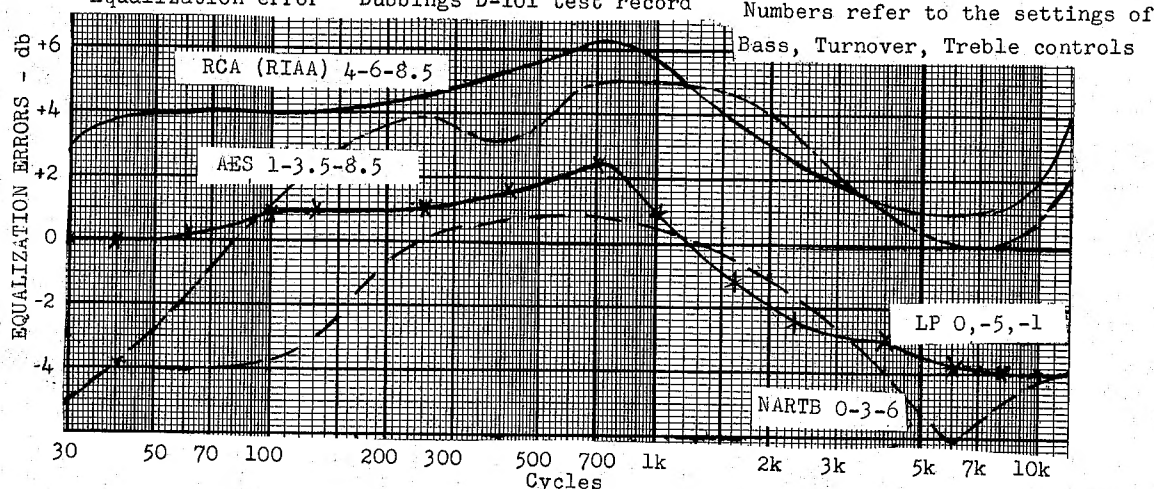
against the record. A safety limit screw prevents the stylus from contacting the turntable if no record is on it. A very convenient curved finger lift, vastly improved over the type used on early models of the arm, completes the picture.

The base of the arm is floated on rubber, in such a manner that it is very well isolated from any motorboard vibration. The mount almost seems too loose, since it appears that the arm could be cocked to one side, causing improper tracking. We found no indication of this happening on the system we tested, however.

Since gravity plays no significant part in determining stylus pressure, the Weathers arm may be played in any position - literally. We played our test unit at about an 85° angle - almost vertical - with no degradation of performance that we could detect. We were only limited by the record falling off the turntable at 90°. With a means of keeping it on the turntable, we have no doubt the Weathers system could play upside down, still at 1 gram pressure. As for why anyone might want to play it upside down, well . . . that is in the class of writing underwater with a ball-point pen. Seriously, though, this arm is more nearly independent of its environment than any other we've seen. Shocks and vibration that would send other arms skittering wildly across the record leave the Weathers unaffected, and it does not rely on excessive stylus pressure to achieve this result (quite the contrary).

WEATHERS PREAMPLIFIER

Equalization error Dubbings D-101 test record



The Weathers arm will only accept the Weathers cartridge, and conversely, the cartridge can only be used in this arm. To insure this, a sliding clip arrangement is used for mounting the cartridge, instead of the usual screws on $\frac{1}{2}$ " centers. In the past, Weathers made a less compliant model for record changers, but we don't see that being advertised nowadays.

The G.I. turntable used in the Debonnaire is not expensive (\$15. net) and is modified only in that the table is painted flat black instead of flocked. A small rubber disc the size of a record label, with three "dimples" raised on it fits over the spindle. The record label contacts the three dimples and no other part of the record touches any part of the turntable. The low tracking pressure of the Weathers system makes this feasible, since there is no tendency for the stylus to push the record downward, even though it is unsupported at the point of contact.

One advantage of these features is that the record doesn't pick up the dust and lint that it would normally encounter on a flocked turntable. Another one, more striking, is the fact that it

acts as an effective rumble isolator. We have checked other DSS units in conventional installations and found a rumble of -20 db relative to 9 cm/sec. to be typical (our Rek-O-Kut T12 measured -40 db with the same techniques). The Weathers system gave professional turntables a close race, with a -37 db rumble level. We think this is most remarkable from an inexpensive turntable, and must be credited to the rubber disc Weathers uses, so far as we can tell. Of course, this was a test of only one sample, and we have no way of knowing how consistent this performance may be. Weathers makes no claims on this subject. In any event, the low rumble combined with unusually low hum and hiss level made it possible to operate the Weathers system at extremely high levels into a Karlson Altec 604 speaker system via a 50 watt McIntosh amplifier without objectionable background noise.

As we've mentioned, the turntable ran slow by 3% or so, preventing any valid listening tests or A-B comparisons with other systems. We don't see how this particular turntable passed inspection at either General Industries or Weathers. The peculiarities of the preamplifier likewise prevented any determination of the true mettle of the cartridge. We intend to obtain another arm and oscillator, minus preamplifier and turntable, and settle the matter finally.

In the meantime, we can give a resume of the experiences of several of our readers and a couple of our staff members, who have Weathers systems.

Early Weathers units suffered from a variety of troubles which gave them a bad name in some quarters. Typical complaints were oscillator drift, requiring frequent readjustment, microphonic oscillators, noisy or microphonic cables from cartridge to oscillator, an extremely awkward finger lift on the arm, etc. These have generally been eliminated or corrected, we are happy to say. The unit we tested showed absolutely no microphonism or noise, needed no adjustment of the oscillator during the two months we had it, and had one of the handiest finger lifts in the business.

All of our readers who have written us about their experiences with Weathers system agree that it is capable of unsurpassed performance when properly adjusted. Some users are willing to put up with any inconvenience involved in getting peak performance from their pickups; others are regret-

fully switching over to magnetic pickups which they feel give comparable performance (ESL and Ferranti, in two cases we know of). Perhaps all of these users have older models of the Weathers system.

At the time the Weathers pickup was introduced, several years ago, it set new standards of performance. For at least two years no magnetic pickup could match it for smoothness and extended range. Now the situation has changed. Several magnetic pickups are on the market which rival or even surpass the electrical performance of the Weathers, with generally greater reliability, lower cost, and freedom from fussiness. We believe that the position of the Weathers in the high quality pickup field must rest on the factor of record wear. The low mass and high compliance of this design would indicate a very good standing in this respect, and indeed this is one of Weathers' strongest advertising claims. Nevertheless, we have never seen any objective, unbiased, controlled test data on the subject of record and stylus wear. Many points of view have been expressed on the subject, frequently in strong opposition to other views, never documented, and only adding to our confusion.

When and if we make the study of record wear we mentioned elsewhere in this issue, we hope to find the true answer, if one exists, to the question "Which arm/cartridge combination is easiest on my records?". Until then, our ratings must rest on the electrical tests and comparative listening tests.

For the impatient reader who wants the story in kilocycles and decibels, we can offer only the following meager data, taken on an early Weathers unit owned by one of our staff. This cantankerous device needed readjustment before every playing period, and more time was spent adjusting it than listening to it. When it finally was tuned up, the transparent purity and cleanness of reproduction were a joy to hear. Really superb. That's why loyal Weathers owners are willing to put up with the idiosyncracies of this device, in the hope of an ultimate auditory reward.

The response of this particular unit, on a Cook Series 10 record, was flat ± 1 db from 35 to 20000 cycles, except for a gentle 3 db peak at 17 kc. This rise started at 12 kc and fell off gradually to ± 1 db at 20000 cycles. Subsequent tests have given us reason to think that the Cook record we used had a 2 db peak at 17kc, so you can figure out for yourself how flat the pickup must have been!

Both this unit and the one on the Debonnaire passed the Cook Series 50 IM test easily. Needle talk of the Weathers is very low. Only the ESL Concert and Professional series cartridges surpass it in this respect.

Summarizing, we would say that a properly operating Weathers system ranks very high in the hierarchy of pickups - certainly in the top two categories listed in our Summary in the last issue and perhaps even in the uppermost listing. Nevertheless, we cannot recommend it to the average audiophile because of its extreme delicacy and general fussiness. The confirmed gadgeteer or tinkerer may find it more to his liking.

The Debonnaire, in spite of many excellent and ingenious features, cannot be recommended because of the preamplifier, which we consider substandard in performance and grossly overpriced.

ELECTRO-VOICE MODEL 84 CERAMIC CARTRIDGE

We had intended to report on the E-V 84 ceramic cartridge in this issue, and in fact had performed a number of tests on one sample. However, we have been advised by E-V that there would be little purpose in reporting on the Model 84, since it is being superseded in hi-fi applications by the new Model 80.

For the benefit of those readers who already own a Model 84, or may be interested in purchasing one from a dealer's stock, we will offer a brief run-down on our experience with it.

1) It is apparently an extremely good amplitude responding device (± 2 db, 30-13000 cycles) but equalization errors for the RIAA curve seemed somewhat higher than the $\pm 2\frac{1}{2}$ db claimed by E-V. Corrective equalization should be easy to apply.

2) When connected to the magnetic cartridge input of an amplifier, the response is extremely smooth and free of peaks up to 13 kc, above this it falls off sharply.

3) It has the same advantages and limitations as the other ceramic cartridge we have covered (Sonotone LP, Vol. 1, No. 6/7, page 14). Electrostatic hum pickup is a problem. Output is about 0.5 volts at 9 cm/sec and 1000 cycles.

4) It is longer than other cartridges, and will not fit most good arms. Mounting is possible in record changers, Livingston arms, and the B-J arm (which we used).

5) The Cook Series 50 IM test record is passed easily. Listening quality is excellent. Unfortunately, we were unable to A-B compare it to a variety of cartridges, but we would place it at least in the category of the GE and Ronette cartridges. It definitely is smoother and has a wider frequency range than either of these.

6) We think it is significant that the new E-V Model 80 is designed to replace a magnetic cartridge, working into a low level preamplifier input. We have previously pointed out that good amplifiers which can effectively utilize the special characteristics of piezo-electric cartridges are neither common nor cheaper.

We expect to obtain a Model 80 cartridge when it becomes available, and will report on it in full at that time.

BACK ISSUES

All back issues are now available. If you recently requested (after July 1) particular back issues, you should have received it already. If you are missing any issue from your file, or desire extra copies, they can now be obtained at a cost of \$.35 each. (Quantity prices are available on request). If you send in a renewal of your subscription within the next thirty days or so, such back issues, at your request, will be sent right away and counted against your subscription extension. For instance, if you desire issues #1 and #5 and your subscription expires with Vol. 2, No.3 (there are 12 issues per volume), you would receive for your renewal the back issues and your subscription would be extended to Volume 3, No. 1.

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NATIONAL HORIZON 5 PREAMPLIFIER

An important part of the National Company's well integrated line of hi-fi components is the Horizon 5 preamplifier. This unusually compact unit is designed for insertion into either the Criterion tuner or the Horizon 20 power amplifier. In a system employing these components, the control functions can be located either at the tuner or at the power amplifier, by merely plugging the preamplifier into the appropriate unit.

Although the Horizon 5 is specifically designed for use with National equipment, there are 3 foot and 15 foot cable assemblies available which enable it to be used with other makes of amplifiers. It is not self-powered, but the modest heater and plate power requirements can be obtained from most power amplifiers. Some soldering iron work will probably be involved in such adaptation.

The front panel of the Horizon 5 is only 2" x 8½", and the main body of the preamplifier, which is considerably smaller than that, only extends 4½" to the rear. On the panel are a selector, bass and treble tone controls (with flat or center positions indicated), and a loudness control. A push button switch permits using the loudness compensation or removing it at will, with no change in volume level.

The selector switch permits a choice of tape recorder, TV sound, or tuner inputs, as well as a magnetic phono cartridge input. Equalization positions are provided for the NARTB, RIAA, LP, AES and FFRF recording characteristics, as well as one with no high frequency rolloff for foreign records and one for noisy 78 RPM records. Audio League measurements show the equalization, at least on the more commonly used characteristics, to be excellent over the entire audible range.

The bass tone control is rated to provide a control range of +25 db to -15 db at 30 cycles, relative to the level at 1000 cycles. Our measurements confirm this claim, indicating +22.5 db to -15 db control range at 30 cycles. A unique feature of this tone control is the fact that, instead of its operation "hinging" around 800 cycles, as do most tone controls, the extreme low frequencies are affected before the higher frequencies are. A very appreciable amount of boost or cut can be obtained below 100 cycles without affecting the frequencies above that. This makes possible some remarkable effects. The region below 60 or 70 cycles where many speakers are deficient, can be boosted 10 to 15 db without introducing objectionable boominess on male voices, for example. In contrast, a hinged tone control giving this amount of boost will usually provide several db of boost in the 200-300 cycle region, giving rise to a boomy or muddy quality. At full boost, the National has a response characteristic quite similar to that of conventional tone controls.

The treble control is rated +12 db to -25 db at 10 kc. We measured +10 db to -25 db at 10 kc. The treble response curves are more like those we have seen on other preamplifiers.

National states the response to be flat ± 0.25 db from 20-30000 cycles. Possibly with a bit of juggling of tone controls, we could have matched this, but by merely setting them to their indicated flat positions we measured a ± 2 db variation from 20-20000 cycles. Between 50 and 5000 cycles the response was unusually flat, within a few tenths of a db. The absence of any sort of bump or irregularity in the response curve is noteworthy.

The loudness compensation, which affects only the low frequencies, is moderate in degree. It was not possible to get the amount of compensation found in some other commercial preamplifiers, but the effect was pleasing and no objectionable tubbiness was heard.

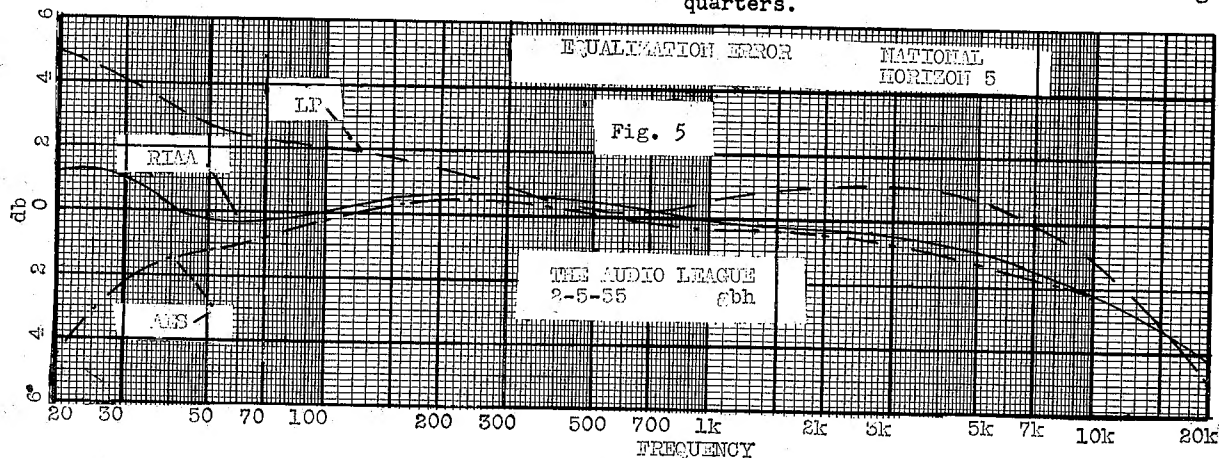
On the back of the unit are individual level controls for the TV and tape input channels. They are designed to accommodate input signals of 50 millivolts to 5 volts. A slide switch inside the preamplifier selects either 10 mv. or 30 mv. magnetic cartridge inputs. The higher input is intended for the Pickering or any other high output cartridge, while GE, Fairchild and most others will require the lower input setting. A hum-bucking adjustment is also located internally.

The rated nominal output of the Horizon 5 is 1.5 volts RMS, with a 15-volt maximum. We found that it would deliver 30 volts before any visible clipping could be observed on an oscilloscope. This is considerably more than would ever be required in a practical installation. Distortion at ordinary output levels of 1 volt or less is almost unmeasurable.

National claims hum levels of -70 db on TV input and -50 db on 10 mv. phono input, both relative to 1.5 volts output. The Audio League measured hum levels of -65 db and -42 db respectively, relative to 1.5 volts output. These figures were obtained with shorted input terminals, maximum gain, flat tone controls and RIAA equalization in the case of the phono input. With open input terminals, the hum levels were far greater. At minimum gain the hum was substantially less than -65 db. In listening tests, hum was quite inaudible at all times.

Our measurements show that in order to obtain 1 volt output, it is necessary to apply 4.5 mv. to the 10 mv. phono input, or 30 mv. to the TV, tape or tuner inputs.

Internally, the Horizon 5 is quite closely packed with components. Portions of the circuit are assembled on printed boards. Servicing this unit, beyond tube replacement, would be a fairly tricky job unless one were accustomed to working in close quarters.



ISSUE SIZE

A couple of interesting features are worth mentioning. The plug on the back of the preamplifier, when inserted into either the Criterion tuner or the Horizon 20 amplifier, takes over the control of the unit concerned. Signal and power leads are routed through the preamp automatically. In the case of the Criterion tuner, the tuner filaments are only turned on when the selector switch is in the tuner position. At all other times, only the audio and power supply sections of the tuner are turned on. The loudness control is a dual unit, effective on both AM and FM channels when the tuner is used binaurally. The tone controls, on the other hand, affect only the FM channel of a binaural broadcast.

Figure 5 shows the equalization error of the Horizon 5 for LP, RIAA, and AES characteristics. These characteristics are unusually well equalized. We haven't seen many preamplifiers at any price that can do a better job of phono equalization.

Figure 6 shows the extremes of tone control action, as well as a typical intermediate bass tone control setting. The latter curve was taken with the bass tone control set at "3 o'clock", which represents a fairly large bass boost. No boominess whatever is introduced by this amount of boost.

Also shown in Fig. 6 is the action of the loudness control. This was taken with the loudness control set to reduce the 1000 cycle gain 40 db below its maximum. In practise this represents a typical setting for moderately low level listening.

Summarizing, we find the National Horizon 5 preamplifier to be a compact, flexible, and honestly rated unit. In addition to its being a logical choice for anyone with a National tuner or power amplifier, it is well worth considering for inclusion in any good hi-fi system. We don't know any commercially manufactured preamplifier at or near its price (\$49.95) which can compete with the Horizon 5 from the standpoints of flexibility, compactness, and good performance.

Our regular size issue is eight pages. Occasionally we may combine issues in order to preserve the continuity of the subject matter, as was done for issues 6 and 7. We normally have a good amount of material that we are unable to present for lack of space. We would always like to present comparative or related reports in the same issue but this too becomes impossible in eight pages - even with our small size type.

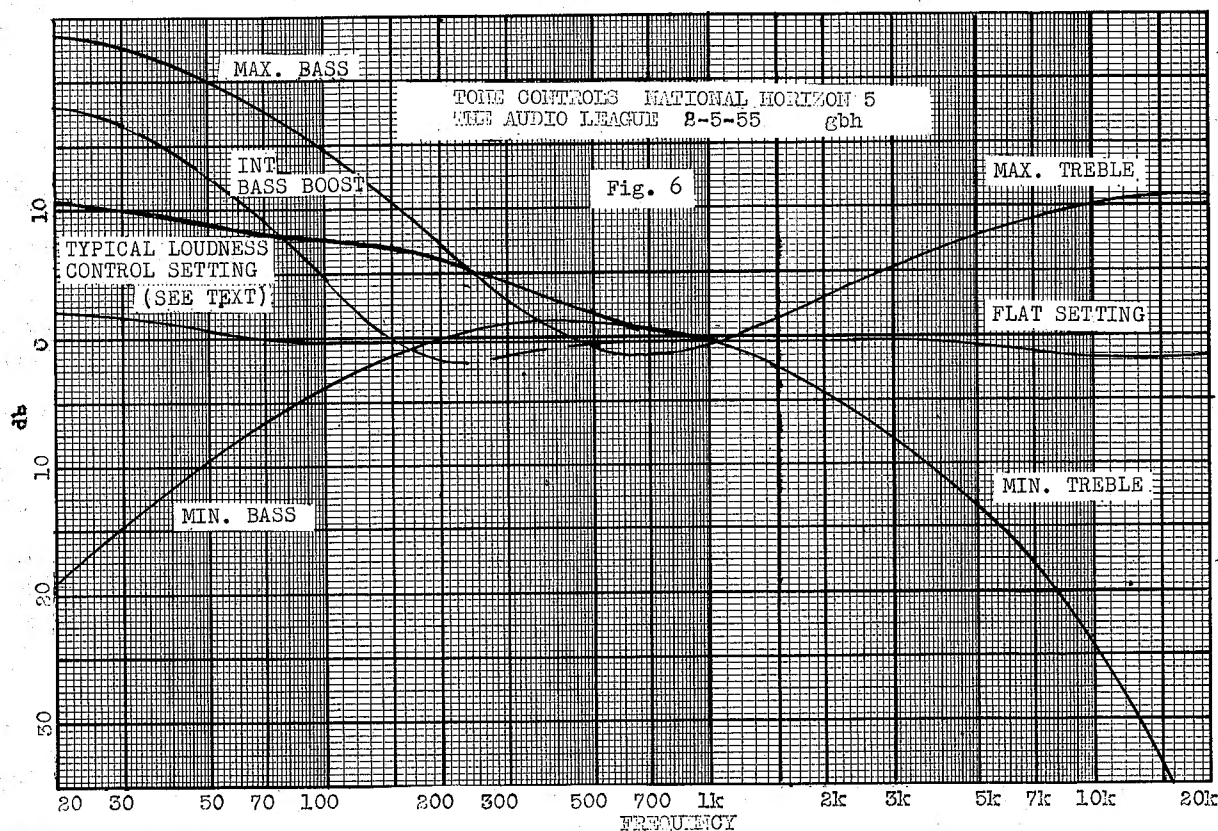
Because of the excellent response on the part of most of our readers, to our plea for getting more subscribers, we had sufficient funds this month to publish an additional four pages of related material and a long held back report. If our number of subscribers continues to increase at the rate of last month, all subscribers will benefit by our being able to improve the reports in content, size, and regularity.

REPORTS IN PROGRESS

Reports on the following are scheduled for early release:

- Acoustic Research AR-1 speaker system
- National Catenoid speaker system
- Craftsman C-900 FM Tuner
- REL Precedent FM Tuner
- Bogen DB20DF and DB110 amplifiers
- Recoton cartridge
- Record Changers (several makes)

The next issue of the REPORT will definitely cover the 12" and 15" Karlson enclosures, plus several of the above listed items, as space will allow.



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We wish to thank those of our readers who responded so enthusiastically to our appeal for more subscribers. It has not been possible to answer you individually, but we are most appreciative of your generous assistance.

Many have given gift subscriptions of both yearly and trial durations. This, we believe, is the best gift both the recipient and the Audio League could receive. Since the Audio League Report is its own best advertisement, increased circulation brings further increases in circulation as more hi-fi enthusiasts are shown copies.

We also received a number of contributions, some anonymous. This really touched us, and we most sincerely wish to thank you for your generosity. Eventually we will get around to thanking the known contributors and asking you individually to send us a list of persons to receive gift subscriptions. If you were kind enough to send us a contribution, please send us a list of your friends so that your generosity might include them. Gift subscriptions are at the rate of \$2.50 each for 3 or more.

We have a special mailing piece with a montage of some of our articles and reports which we send to the list of names of hi-fi fans you have been sending us. Keep the lists coming, please, the response has been excellent from such mailings.

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